swered *true* to the statement "human beings, as we know them today, developed from earlier species of animals," representing a major change in response to this question[14] and bringing the United States more in line with other industrialized countries in response to this question (Gendall, Smith, and Russell 1995).

Gallup polls taken during the past 20 years consistently show a plurality (45 percent in February 2001) of Americans agreeing with the statement: "God created human beings pretty much in their present form at one time within the last 10,000 years or so" (Brooks 2001).

In addition, two-thirds of those surveyed (68 percent) favor teaching this belief (known as creationism) along with evolution in public schools, although 29 percent are opposed. However, 55 percent are opposed to teaching creationism *instead* of evolution (*Gallup News Service* 2000).

A study conducted for the People for the American Way Foundation took a closer look at the question of teaching evolution and found an overwhelming majority of Americans (83 percent) agreeing that it should be taught in the classroom. However, there is also strong support for teaching creationism. A detailed breakdown of the survey findings shows a wide range of opinion on the issue:

- 20 percent favor teaching only evolution and nothing else in public schools;
- 17 percent want only evolution taught in science classes but say that religious explanations can be discussed in other classes;
- 29 percent do not have a problem with creationism being discussed in science classes but believe it should be discussed as a "belief," not a scientific theory;
- 13 percent believe that both evolution and creationism should be taught as scientific theories in science class;
- 16 percent want no mention of evolution at all;
- 4 percent are in favor of teaching both evolution and creationism but are unsure about how to do it; and
- 1 percent have no opinion (People for American Way Foundation 2000).

Understanding the Scientific Process

The NSF survey also includes questions intended to determine how well the public understands the scientific process. Respondents are asked to explain what it means to study something scientifically.[15] In addition, respondents are asked questions pertaining to the experimental evaluation of a drug and about probability.[16]

In 2001, 33 percent of respondents provided good explanations of what it means to study something scientifically.[17] A large minority (43 percent) answered the experiment questions correctly, including the question(s) that focused on the use of control groups. A majority (57 percent) answered the four probability questions correctly. (See appendix table 7-11.)

A combination of each survey participant's responses to the three items is used to estimate his or her overall level of understanding of the scientific process. To be classified as "understanding the scientific process," a respondent must answer all the probability questions correctly and either provide a "theory testing" response to the question about what it means to study something scientifically or provide a correct response to the open-ended question by explaining why it is better to test a drug using a control group. In 2001, 30 percent of respondents met these criteria. (See footnote 10, figure 7-5, and appendix table 7-11.)

Public Attitudes Toward S&T, Scientific Research, Federal Funding of Scientific Research, and Specific Science-Related Issues

In general, Americans express highly favorable attitudes toward S&T. In 2001, overwhelming majorities of NSF survey respondents agreed with the following statements:

- "Science and technology are making our lives healthier, easier, and more comfortable." (86 percent agreed and 11 percent disagreed)
- "Most scientists want to work on things that will make life better for the average person." (89 percent agreed and 9 percent disagreed)
- "With the application of science and technology, work will become more interesting." (72 percent agreed and 23 percent disagreed)
- "Because of science and technology, there will be more opportunities for the next generation." (85 percent agreed and 14 percent disagreed) (See appendix table 7-12.)

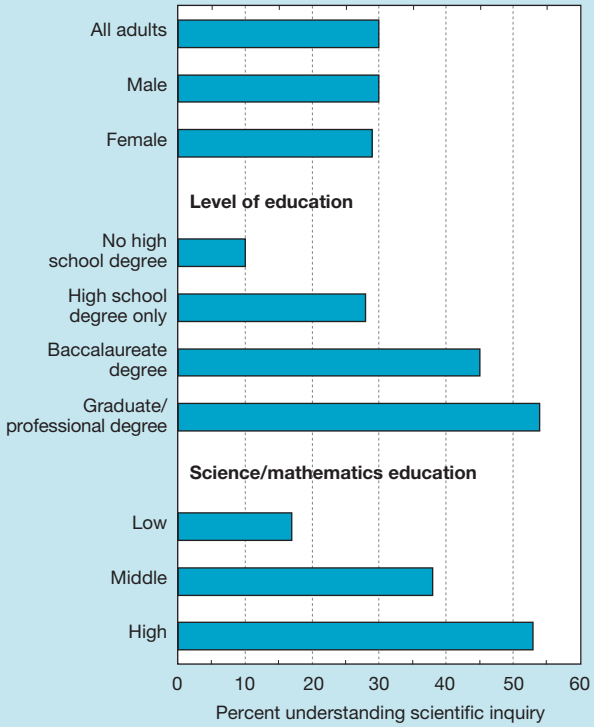
[14]For example, the comparable percentages for 1985, 1990, 1995, and 1999 were 45, 45, 44, and 45 percent, respectively.

[15] The question was: "When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?" If the response is "clear understanding" or "general sense": "In your own words, could you tell me what it means to study something scientifically?"

[16]The question pertaining to experimental evaluation was: "Now, please think of this situation. Two scientists want to know if a certain drug is effective in treating high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?" The text of the probability question was: "Now think about this situation. A doctor tells a couple that their 'genetic makeup' means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?"

[17]Correct explanations of scientific study include responses describing scientific study as theory testing, experimentation, or rigorous, systematic comparison.

Figure 7-5.
Public understanding of nature of scientific inquiry: 2001



NOTE: Survey respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college math/science courses. They were classified as "middle" if they took six to eight such courses, and "low" if they took five or fewer.

See appendix tables 7-11. *Science & Engineering Indicators – 2002*

In addition, Americans seem to have more positive attitudes toward S&T than their counterparts in the United Kingdom and Japan.[18] (See text table 7-3.)

Despite these positive indicators, a sizable segment, although not a majority, of the public has some reservations concerning science and especially technology. For example, in 2001, approximately 50 percent of NSF survey respondents agreed with the following statement: "We depend too much on science and not enough on faith" (46 percent disagreed). In addition, 38 percent agreed with the statement: "Science makes our way of life change too fast" (59 percent disagreed). (See appendix table 7-12.)

Over time these percentages have remained nearly constant, with only slight variation from survey to survey. For example, since 1983, at least 80 percent of survey respondents have agreed that "science and technology are making our lives healthier, easier, and more comfortable." The percentages have ranged from 84 percent in 1983 and 1990 to 90 percent in 1999. Similarly, the percentage disagreeing that "we depend too much on science and not enough on faith" has ranged from 39 percent in 1985 to 48 percent in 1997. (See appendix table 7-13.)

In addition, an increasing number of people believe that the benefits of scientific research outweigh any harmful results. (See "Public Attitudes Toward Scientific Research.") The concerns that do exist are related to the effect of technology on society. For example, in 2001, a sizable minority, 44 percent, agreed with the statement that "people would do better by living a simpler life without so much technology." (See appendix table 7-14.) Also, about 30 percent of respondents agreed that "technological discoveries will eventually destroy the Earth" and that "technological development creates an artificial and inhumane way of living." (See appendix tables 7-15 and 7-16.)

The existence of public concern about the effect of technology on society does not negate the fact that the vast majority of Americans have highly favorable opinions of technology and are highly appreciative of the role of S&T in the history and economic success of the United States. Results from various surveys show the following:

- More than 90 percent think science and technology have been important "in establishing the United States' influence in the world" and "to America's economic success in the 20th century"; 60 percent think they have been very important. Also, 90 percent believe that science and technology have changed life during the past 100 years for the better, and more than 70 percent say they were more likely to vote for a candidate "who places a high priority on strengthening science and technology" (Bayer/NSF 2000).
- Eighty-nine percent think science and technology will play a major role "if life is going to be better in this country in the future (Pew Research Center for the People and the Press 1999a)." More people gave this response for science and technology than for any other item in the survey, including medical advances, which got the second highest vote of confidence. Also, the 89 percent statistic represents a substantial increase over the corresponding 77 percent recorded in the 1996 version of the survey.[19]
- Americans also believe that advancements in science and technology were the nation's and the government's greatest achievements during the 20th century. The space program tops the list of those achievements, followed by technology in general, and computers. More than 70 percent of those surveyed said that the invention of airline travel and television were a change for the better; more than 80 percent gave the same response for the highway system and computers; and more 90 percent put the automobile and radio in the "change-for-the-better" category.

[18]In a 1998 study conducted in Japan, 81 percent of those surveyed agreed that "advancements in science and technology are too rapid to keep up with," and 84 percent agreed that "science and technology can be abused or misused." The comparable percentages in 1995 were 54 and 78 percent, respectively. In addition, in 1998, only 58 percent agreed that there are more positive than negative aspects to science and technology (up from 52 percent in 1995) (Prime Minister's Office 1995; "Public Opinion Survey on Future Science and Technology" 2001).

[19]However, it should be noted that the percentage of people identifying "the pace of technological change" as a major threat to "our country's future well-being" rose from 29 percent in 1996 to 35 percent in 1999.

Text table 7-3.
International comparison of attitudes toward science and technology (S&T)

Attitude	Agree (percent) U.S. (2001)	U.K. (2000)	Japan (1995)
S&T are making our lives healthier, easier, and more comfortable.	86	67	51
In general, scientists want to make life better for the average person.	89[a]	67	45[b]
Because of S&T, there will be more opportunities for the next generation.	85	77	NA
We depend too much on science and not enough on faith	51	38	53
It is important to know about science in my daily life.	84[c]	59	71[c]
Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Government.	82[d]	72	80
Science makes our lives change too fast.	38	44	NA
The benefits of science are greater than the harmful effects.	72	43	64[e]

[a]Phrased as, "Most scientists want to work on things that will make life better for the average person."

[b]Those disagreeing that "there are a lot of scientists who have no interest in either human beings or society."

[c]Only "disagree" data available.

[d]The U.S. question refers to support by the Federal Government.

[e]Those disagreeing with the statement, "I cannot find any value in the activities of scientists and engineers."

SOURCES: This table is reproduced from The Office of Science and Technology and The Wellcome Trust report, "Science and the Public: A Review of Science Communication in the United Kingdom" (London, UK, March 2000). U.S. data have been updated from the National Science Foundation, 2001 Survey of Public Attitudes Toward and Understanding of Science and Technology (Arlington, VA, 2001).

Science & Engineering Indicators – 2002

The only technologies not receiving strong public endorsement were nuclear energy and nuclear weapons. Among technologies introduced in the past decade, Americans are the most enthusiastic about communication technologies, such as email, the Internet, cellular phones, and cable TV, and the least enthusiastic about fertility drugs, Prozac, Viagra, and the cloning of sheep (Pew Research Center for the People and the Press 1999b).

♦ Eighty-seven percent agree that "technology in general makes a positive contribution to society"; only 3 percent think that it makes a negative contribution (American Association of Engineering Societies 1998).

Trends in Attitudes Toward S&T

To track trends in public attitudes toward S&T, an Index of Scientific Promise and an Index of Scientific Reservations were developed.[20] In addition, the ratio of the Promise Index to the Reservations Index is a useful indicator of current and changing attitudes toward S&T. The ratio fell from 1.46 in 1999 to 1.30 in 2001 largely because of a decline in the Index of Scientific Promise. Thus, although people still have highly positive attitudes toward S&T, their attitudes may have been somewhat less positive in 2001 than they were two years earlier. The change occurred across all education groups and among both sexes. (See appendix table 7-17.)

Public Attitudes Toward Scientific Research

An overwhelming majority of Americans consistently believe that the benefits of scientific research outweigh any harmful results. In 2001, 47 percent of NSF survey respondents said that the benefits *strongly* outweighed the harms, and 25 percent said that the benefits *slightly* outweighed the harms. These percentages have remained nearly constant during the past two

[20]The Index of Scientific Promise and the Index of Scientific Reservation are factor scores converted to a 0–100 scale. The Index of Scientific Promise includes agreement/disagreement responses to the following survey items: "science and technology are making our lives healthier, easier, and more comfortable"; "most scientists want to work on things that will make life better for the average person"; "with the application of science and new technology, work will become more interesting"; and "because of science and technology, there will be more opportunities for the next generation." The Index of Scientific Reservation includes agreement/disagreement responses to the following survey items: "we depend too much on science and not enough on faith"; "it is not important for me to know about science in my daily life"; and "science makes our way of life change too fast." A factor analysis verified the existence of a two-factor structure. The lowest possible factor score (strong disagreement with all of the items) was set to 0, and the highest possible factor score (strong agreement with all of the items) was set to 100. All factor scores between the highest and the lowest were placed on the 0–100 scale accordingly.

decades, as has the percentage of respondents taking the opposite view that the harms outweigh the benefits. However, the most recent data show the latter (which had been in the teens for most of the past two decades) declining from 15 percent in 1999 to 10 percent in 2001. Concurrently, the percentage of respondents saying the benefits were *equal* to the harmful results increased from 11 percent in 1999 to 19 percent in 2001. (See figure 7-6 and appendix table 7-18.)

Men express greater confidence than women that the benefits of scientific research outweigh the harmful results. About three-fourths of the men, compared with approximately two-thirds of the women, agreed that the benefits outweighed the harms. Level of education is also strongly associated with a positive response to this question. Those who did not complete high school were less likely than those with more formal education to believe that the benefits outweighed the harms, although it should be noted that even 55 percent of this group said the benefits outweighed the harms. The corresponding percentages for high school graduates and for those having at least a bachelor's degree were 70 and 87 percent, respectively. (See appendix table 7-18.)

Public Attitudes Toward Federal Funding of Scientific Research

All indicators point to widespread support for government funding of basic research. In 2001, 81 percent of NSF survey respondents agreed with the following statement: "Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Federal Government."[21] (See appendix table 7-19.) The level of agreement with this statement has consistently been in the 80-percent range. In 2000, 72 percent of U. K. residents agreed with the statement, as did 80 percent of Japanese residents (in 1995). (See text table 7-3.)

If the stability and lack of variation of this measure of public support for basic research are noteworthy, so is the consistently small number of people who have the opposite viewpoint. In 2001, 16 percent disagreed with the statement; the same level of disagreement had been recorded two years earlier. (See appendix table 7-20.)

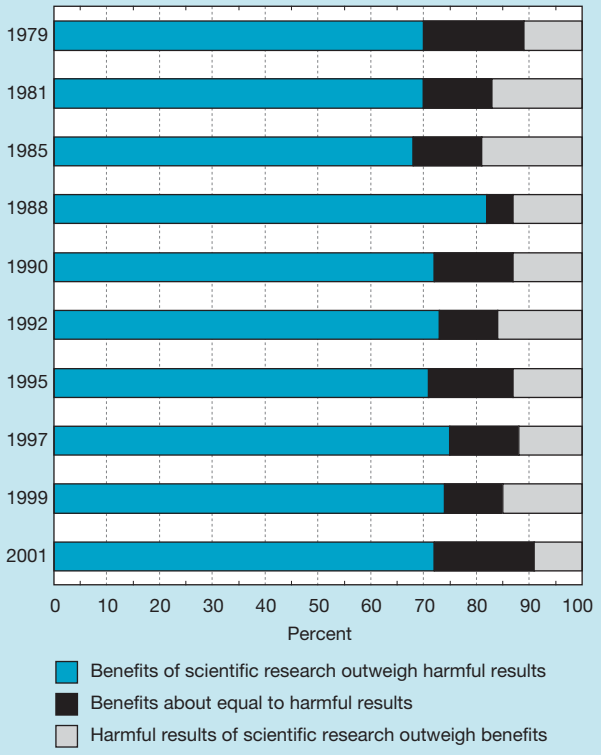
Although there is strong evidence that the public supports the government's investment in basic research, few Americans are able to name the two agencies that provide most of the Federal funds for this type of research. In a recent survey, only 5 percent identified the National Institutes of Health (NIH) as the agency that "funds most of the taxpayer-supported medical research performed in the United States," and only 3 percent named NSF as "the government agency that funds most of the basic research and educational programming in the sciences, mathematics and engineering." (Research!America 2001).[22]

In addition, those with more positive attitudes toward S&T were more likely to express support for government funding of basic research. In 2001, 93 percent of those who scored 75 or higher on the Index of Scientific Promise agreed that the Federal Government should fund basic scientific research compared with only 68 percent of those with relatively low index scores. (See figure 7-7 and appendix table 7-20.)

In 2001, only 14 percent of NSF survey respondents thought the government was spending too much on scientific research; 36 percent thought the government was not spending enough, a percentage that has grown steadily since 1990, when 30 percent chose that answer.[23] (See appendix table 7-21.) Men are more than likely than women to say the government is spending too little in support of scientific research (40 versus 33 percent in 2001). (See appendix table 7-22.)

To put the response to this item in perspective, at least 65 percent of those surveyed thought the government was not spending enough on other programs, including programs to improve health care, help senior citizens, improve education, and reduce pollution. Only the issues *space exploration* and *national defense* received less support for increased spending than scientific research.

Figure 7-6.
Public assessment of scientific research: 1979–2001



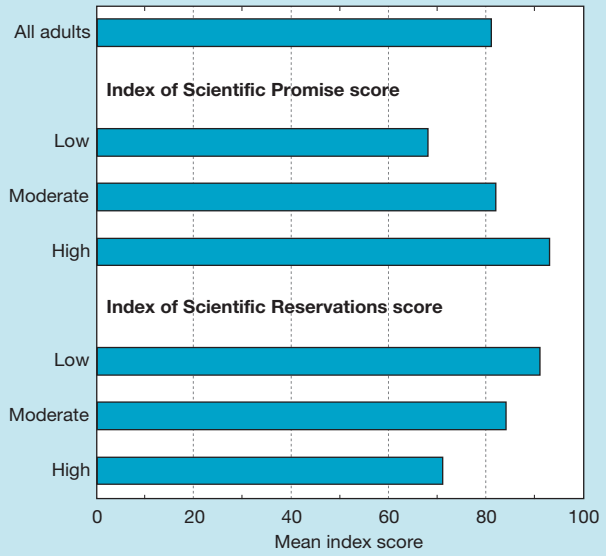
See appendix table 7-18. *Science & Engineering Indicators – 2002*

[21]Another recent poll used almost identical wording and produced a similar result: 78 percent of those surveyed agreed with the statement, 19 percent disagreed, and 3 percent were not sure. In the same poll, 86 percent felt that it was very important that the United States maintain its leadership in scientific research (Research!America 2001).

[22]In the same survey, 64 percent could name the FDA (Food and Drug Administration) and 22 percent knew the name of the CDC (Centers for Disease Control and Prevention) (Research!America 2001).

[23]In a another survey, 41 percent of respondents said they would increase spending on scientific research if they were making up the budget for the federal government; 10 percent said they would decrease spending; and 46 percent said they would keep it the same (Pew Research Center for the People and the Press 2001).

Figure 7-7.
Support for Federal governmental funding of basic scientific research, by level of general support for or reservations about science and technology: 2001



See appendix table 7-20. *Science & Engineering Indicators – 2002*

In 2001, 48 percent of those surveyed thought spending on space exploration was excessive, the highest percentage for any item in the survey—and nearly double the number of those who felt that the government was spending too much on national defense.[24] In contrast, the latter has been falling steadily, from 40 percent in 1990 to 25 percent in 2001. (See appendix table 7-21 and "Public Attitudes Toward Space Exploration.")

Sex as an Indicator of Support for Federal Funding of Scientific Research

Men express more support for Federal funding of scientific research than women. The most recent data show that 86 percent of men and 77 percent of women who responded to the survey agreed that the Federal Government should support basic research. (See appendix table 7-19.)

Level of Education as an Indicator of Support for Federal Funding of Scientific Research

Support for federally funded basic research is tied to education level. In 2001, about 80 percent of those surveyed who had not completed college agreed that the Federal Government should support scientific research compared with about 90 percent of those who had completed college. (See appendix table 7-19.)

[24]CNN/USA Today/Gallup polls show Americans having generally positive views of NASA but little interest in increasing the agency's budget. In December 1999, 16 percent of those surveyed thought NASA's funding should be increased, 49 percent thought it should remain at the current level, and 24 percent thought it should be reduced. In addition, 10 percent thought that funding for the space program should be eliminated entirely. Since Gallup began surveying the public about this subject (in 1984), no more than a quarter of those surveyed have favored an increase in NASA's budget (Carlson 2001).

Public Attitudes Toward Specific Science-Related Issues

Public Attitudes Toward Genetic Engineering

There is no question that genetic engineering has become a hot issue. From the nationwide recall of taco shells containing an unapproved form of genetically modified corn to scientists promising to clone humans in the not-too-distant future, genetic engineering has been the source of a growing number of concerns in recent years. Americans, like their counterparts in other countries, have been trying to understand and weigh the risks and benefits of this issue. In the case of agricultural products, the benefits of expanded yields, reduced perishability, and decreased need for chemical pesticides have been counterbalanced by perceived health and environmental risks and a threat to consumers' ability to make choices about what they eat (Hopkin 2001).

The conventional wisdom that biotechnology[25] is not a contentious issue, including the assumption that opposition is limited to an extremist "fringe," may no longer be true (Priest 2000). The battle for the hearts and minds of the American public is certainly under way:

- Media coverage of agricultural biotechnology increased more than eightfold between 1997 and 2000 (Shanahan, Scheufele, and Lee 2001).
- The PBS documentary series *Frontline* produced "Harvest of Fear," a two-hour special on the subject that aired in April 2001. (See <http://www.pbs.org/wgbh/harvest>.)
- The Biotechnology Association of America spent $7.5 million on political advertising in 2000, more than any other special interest group except one (Goldstein 2001).

Despite the exposure of this issue in the media, the most recent data show that 70 percent of the public consider themselves "not very well informed" or "not informed at all" about modern biotechnology; the corresponding statistic for Europeans is 80 percent (Priest 2000, Gaskell et al. 2000). Available data, however, indicate that awareness is increasing (Shanahan, Scheufele, and Lee 2001).

Even though most people do not consider themselves well informed about biotechnology, there is no shortage of researchers studying public opinion, including an international effort to compare attitudes in the United States, Europe, and Canada (Gaskell and Bauer 2001).[26] In the 2000 U.S. survey, participants were asked to assess six biotechnology applications, which are listed here in rank order from the one receiving the least opposition to the one receiving the most: genetic testing for inherited disease, engineering of bacteria to pro-

[25]Throughout this chapter, the terms *genetic engineering* and *biotechnology* are used interchangeably. A distinction is maintained only to reflect the specific term used in a particular survey and/or by a particular author.

[26]The 1997 U.S. survey was conducted by Jon D. Miller, Chicago Academy of Sciences, and the 2000 U.S. survey was conducted by Susanna Priest, Texas A&M University. The 1996 and 1999 Canadian surveys were conducted by Edna Einsiedel, University of Calgary. The 1997 and 1999 European studies were undertaken by George Gaskell, Martin Bauer, and Nick Alum for the European Commission.

duce pharmaceuticals, genetic engineering of pest-resistant crops, food biotechnology, organ transplants, and animal cloning. In the European survey, genetically modified (GM) food received more negative responses than any other application. (See sidebar "Public Attitudes Toward Biotechnology.")

The 2001 and earlier NSF surveys suggest that the American public is somewhat ambivalent about genetic engineering. Although the evidence is not entirely conclusive, the NSF surveys show the following:

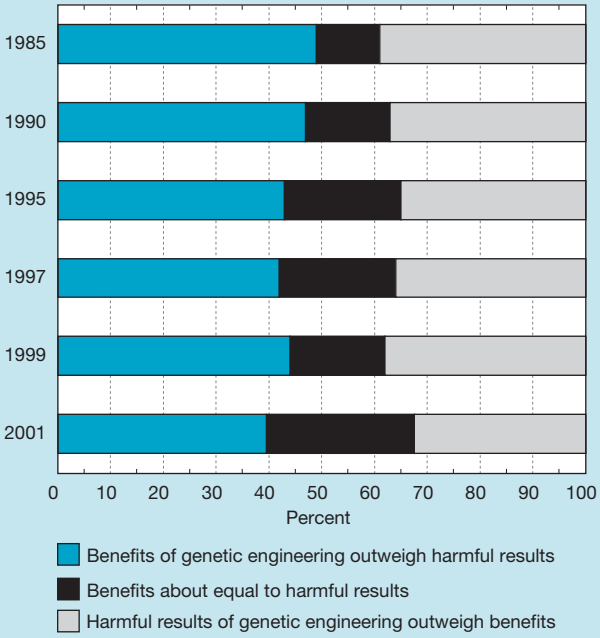
- Support for genetic engineering has never been very high. That is, in no year has a majority of respondents agreed that the benefits outweigh the harmful results.
- Support for genetic engineering has gradually declined during the past 15 years. In 2001, 40 percent of those surveyed thought the benefits outweighed the harms, down from 49 percent in 1985.

The ambiguity in the survey results becomes apparent when one looks at the data on the number of people who think the harms outweigh the benefits. This statistic has also declined in most years, from 39 percent in 1985 to 33 percent in 2001. Consequently, the declining numbers in both the benefits-greater-than-harms and harms-greater-than-benefits categories was offset by a growing number of respondents who think the benefits are equal to the harms. The percentage in this group grew from 12 percent in 1985 to 28 percent in 2001.[27] (See figure 7-8 and appendix table 7-23.)

Men have always had more favorable attitudes than women toward genetic engineering. The gender gap has usually been at least 10 points. In 2001, 45 percent of men and 34 percent of women responding to the survey said that the benefits of genetic engineering outweighed the harmful results. (See appendix table 7-23.)

College graduates are more likely than high school graduates to tout the benefits of genetic engineering. That is, they are both more likely than others to believe that the benefits are greater than the harms and less likely to say that the harms outweigh the benefits.[28] In 2001, 48 percent of survey respondents who had earned college degrees agreed that the benefits outweighed the harms compared with 37 percent of those who had earned only high school degrees and 39 percent of those who had not graduated from high school. Also, 25 percent of the college graduates thought the harms outweighed the benefits compared with 36 percent of high school graduates. The drop in support for genetic engineering during the past 15 years occurred among both high school and college graduates.

Figure 7-8.
Public assessment of genetic engineering: 1985–2001



See appendix table 7-23. *Science & Engineering Indicators – 2002*

Until 2001, the majority (at least 60 percent) of people classified as attentive to science and technology (who may or may not be college graduates) agreed that the benefits of genetic engineering outweighed the harmful results. This statistic dropped from 64 percent in 1999 to 49 percent in 2001. In addition, there was a substantial increase in those saying the harmful results outweighed the benefits, from 20 percent in 1995 to 30 percent in 2001.

Public Attitudes Toward Space Exploration

Public support for space exploration rose during the 1990s, then slipped in 2001. The most recent data show 45 percent of the public agreeing that the benefits of space exploration outweigh the costs, down from 49 percent in 1999. Not since 1985 (before the *Challenger* accident), have more than 50 percent of respondents to NSF's public attitudes survey stated that the benefits of the space program exceeded the costs. The drop in support during the mid-1980s, from 54 percent in 1985 to 47 percent three years later, was particularly dramatic. NSF survey data suggest that most of the public is having difficulty recognizing the benefits of the space pro-

[27]Other researchers have noted that survey participants "have seen more and more risks in agricultural biotechnology as time goes by" and that "the use of biotechnology or genetic modification in food production seems much more acceptable to the public when it is used to enhance food safety than when it is used to improve food quality" (Shanahan, Scheufele, and Lee 2001). In response to one survey, the percentage of people who said that biotechnology would provide benefits for themselves and their families within the next five years fell from 78 percent in March 1997 to 63 percent in October 1999, and 59 percent in May 2000. However, this statistic rose to 64 percent in January 2001 (International Food Information Council 2000). In response to yet another survey, conducted in July 2001, 30 percent of those surveyed thought that foods that have been produced using biotechnology pose a serious health hazard to consumers. The same survey showed that 52 percent of respondents supported the use of biotechnology in agriculture and food production; surveys conducted in 2000 and 1999 produced similar statistics—48 and 51 percent, respectively (Saad 2001).

[28]Another survey produced similar findings (for food biotechnology)—those who did not complete college were less likely than those with college and postgraduate degrees to support biotechnology in food production. For example, 65 percent of those with graduate degrees reported that they supported the technology compared with 59 percent of those with just college degrees, 54 percent of those with some college, and 44 percent of those who had never attended college (Saad 2001).

Public Attitudes Toward Biotechnology

Anti-biotechnology sentiments are much more common in Europe than in the United States.* In addition, the number of people harboring negative attitudes toward biotechnology has increased in both Europe and Canada during the past few years, especially when compared with attitudes in the United States. These are the latest findings from a recent international study conducted in the United States, Europe, and Canada (Gaskell and Bauer 2001; Miller et al. 1999).**

Assessment of Selected Biotechnology Applications

The 1999 and 2000 surveys, which replicate earlier ones conducted in 1996 and 1997, asked respondents to assess the usefulness, risk, and moral acceptability of several applications of biotechnology and to indicate whether they would encourage the use of each application.

Two sets of questions pertained to agricultural applications of biotechnology, including genetic engineering of:

- foods, for example, to make them higher in protein, increase their shelf-life, or improve their taste, and
- crops, for example, to make them more resistant to insect pests.

The three surveys show that Europeans have the least favorable attitudes toward these applications and Americans have the most favorable attitudes, with Canadians placing somewhere in between. For example, in 2001:

- 46 percent of Europeans agreed that genetically modified (GM) food was useful, compared with 57 percent of Canadians and 69 percent of Americans;
- 60 percent of the Europeans agreed that GM food was risky; the corresponding percentages for Canadians and Americans were 58 and 49 percent, respectively;
- only 40 percent of Europeans said that GM food was morally acceptable compared with 55 percent of Canadians and 60 percent of Americans; and
- only 34 percent of Europeans would encourage the production of GM food compared with 48 percent of Canadians and 58 percent of Americans.†

The pattern of responses was similar for attitudes toward GM crops and other plants, although the results reflected somewhat more support for this application of biotechnology. (See figure 7-9.)

What is particularly noteworthy about these data is that they indicate a dramatic drop in support in both Europe and Canada since the surveys were conducted in 1996. In contrast, attitudes in the United States toward GM foods are almost identical to those in 1997, with one slight exception: the proportion of U.S. survey respondents agreeing that GM foods are morally acceptable dropped from 65 percent to 60 percent between 1997 and 2000.‡ Consequently:

- the gap in attitudes between Europeans and Americans, which was not particularly large in the mid-1990s, is now quite wide, and
- Canadians and Americans, who used to harbor similar attitudes, no longer do so; Canadian attitudes now more closely resemble those of Europeans.

The international study included questions pertaining to the following medical applications of biotechnology:

- introducing human genes into bacteria to produce medicines or vaccines (for example, to produce insulin for diabetics), and
- using genetic testing to detect inherited diseases.

Attitudes toward these two medical applications in all three regions were more positive than those for the two agricultural applications. For example, more than 80 percent of Americans and Canadians and 70 percent of Europeans agreed that introducing human genes into bacteria to produce medicines or vaccines was useful. Similarly, at least 75 percent of Americans and Canadians and almost 60 percent of Europeans thought this application was morally acceptable and should be encouraged. However, a pattern similar to that for the agricultural applications should be noted. Between 1997 and 2000, U.S. support for introducing human genes into bacteria to produce medicines and vaccines remained strong while Eu-

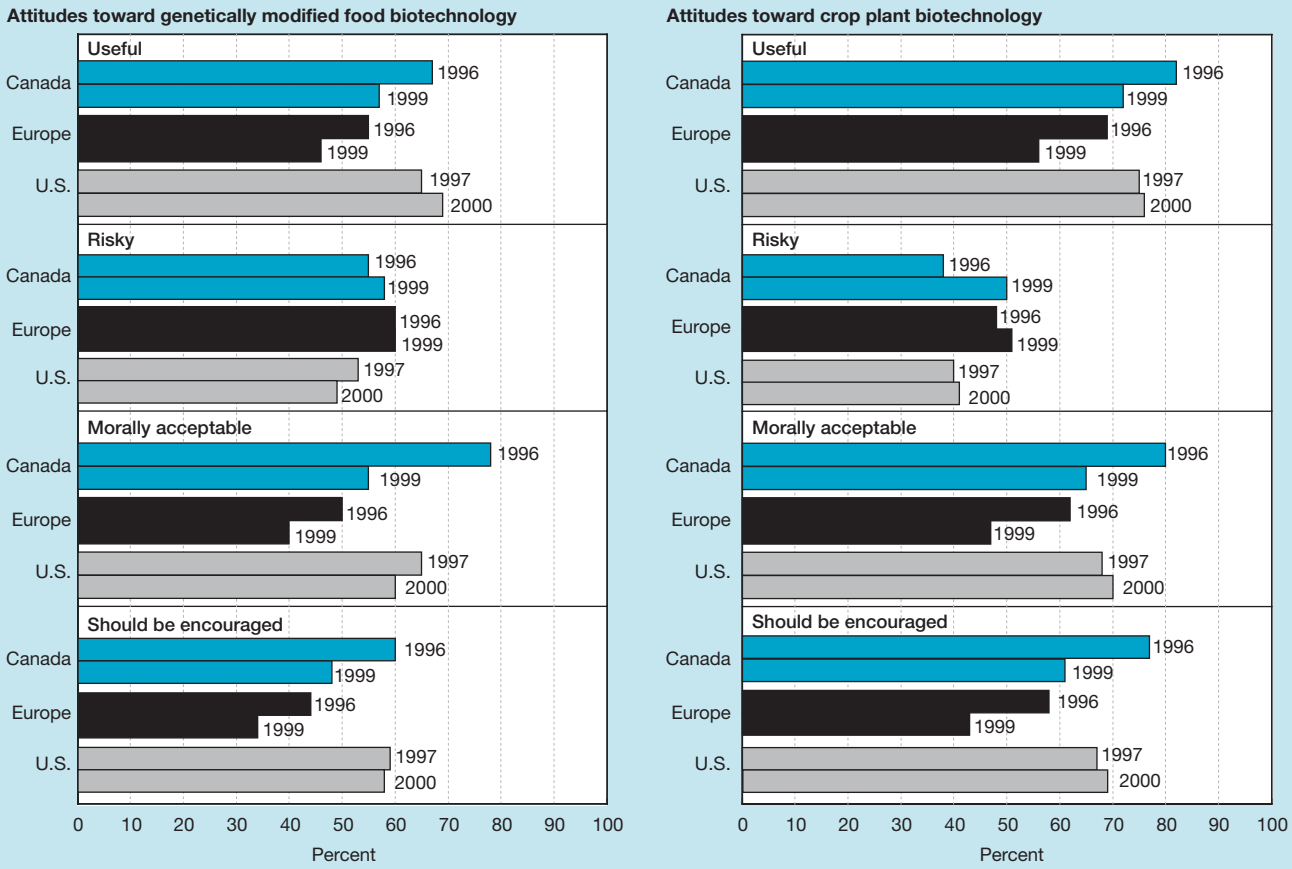
*In the view of a longtime observer of European culture and politics, Europeans seem to be more fearful than Americans of perceived health risks associated with new technologies. Concerns that seem to cause much more consternation in Europe than in the United States—in addition to those about genetically modified organisms (GMOs)—are pork and beef raised with growth hormones; phthalates in plastic toys; measles, mumps, and rubella vaccine; cellular phones; and "economy-class syndrome." The recent experience with bovine spongiform encephalopathy (BSE) or "mad cow" disease, a real health risk, seems to have affected trust in the rest of the food supply, especially anything resulting from new technologies such as GMOs. In addition, there is also an anti-American aspect to the situation. Because American companies are the source of many of the new technologies: "[T]he negative response may tie in with the aversion to globalization among the working class and the anti-Americanism that is never far from the surface among Europe's intelligentsia. People think GMO crops…all come from the U.S." (Reid 2001).

**Seventeen countries were included in the European study, and it should be noted that negative attitudes were more prevalent in some countries than others. (See Gaskell and Bauer 2001.)

†In response to the 2001 NSF survey, 61 percent said that they supported GM food production; 36 percent said that they were opposed. Men (70 percent), college graduates (68 percent), and those classified as attentive to science and technology were more likely than others to favor this application of biotechnology. (See appendix table 7-24.)

‡The 2000 U.S. survey showed that genetically engineered food was of less concern to those surveyed than all other areas of food-related concern, such as bacterial contamination, the use of artificial preservatives, poor nutritional quality, the use of chemical pesticides, diseases from animals that pass to humans, and general food safety (Priest 2000).

Figure 7-9.
Attitudes toward genetically modified food and crop biotechnologies in Canada, Europe, and the United States



SOURCES: Gaskell, G., and Bauer, M.W. (editors) *Biotechnology 1996–2000,* National Museum of Science and Industry (U.K.) and Michigan State University Press. The 1999 and 2000 surveys were conducted by George Gaskell, Martin Bauer, and Nick Alum for the European Commission; Susanna Priest, Texas A&M University; and Edna Einsiedel, University of Calgary. The 1997 U.S. survey was conducted by Jon D. Miller, Chicago Academy of Sciences.

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ropean and Canadian support declined. (See figure 7-10.)

Using genetic testing to detect inherited diseases has the most support across all three regions. For example, at least 80 percent of those surveyed in Canada and the United States agreed that this application was useful and its use should be encouraged.* Moreover, support increased in recent years in both countries. In contrast, it fell in Europe during the same period. In other words, although the residents of all three regions shared similar (highly supportive) sentiments in 1996 and 1997, that is no longer the case. In 1999, 74 percent of Europeans agreed that genetic testing was useful, down from 83 percent in 1996. In addition, 65 percent of Europeans said its use should be encouraged, down from 76 percent in 1996. (See figure 7-10.)

The 1999/2000 surveys also asked respondents in all three regions to assess the usefulness, risk, and moral acceptability of "cloning animals such as sheep whose milk can be used to make drugs and vaccines." Nearly half (47 percent) of European respondents agreed this that application was useful compared with 57 percent of Canadians and 61 percent of Americans. Similarly, only 36 percent of Europeans thought that this application was morally acceptable and would encourage its use, compared with just less than 50 percent of Americans and Canadians.† However, more Americans and Canadians (58 and 61 percent, respectively) than Europeans (54 percent) assigned risk to the use of this application.

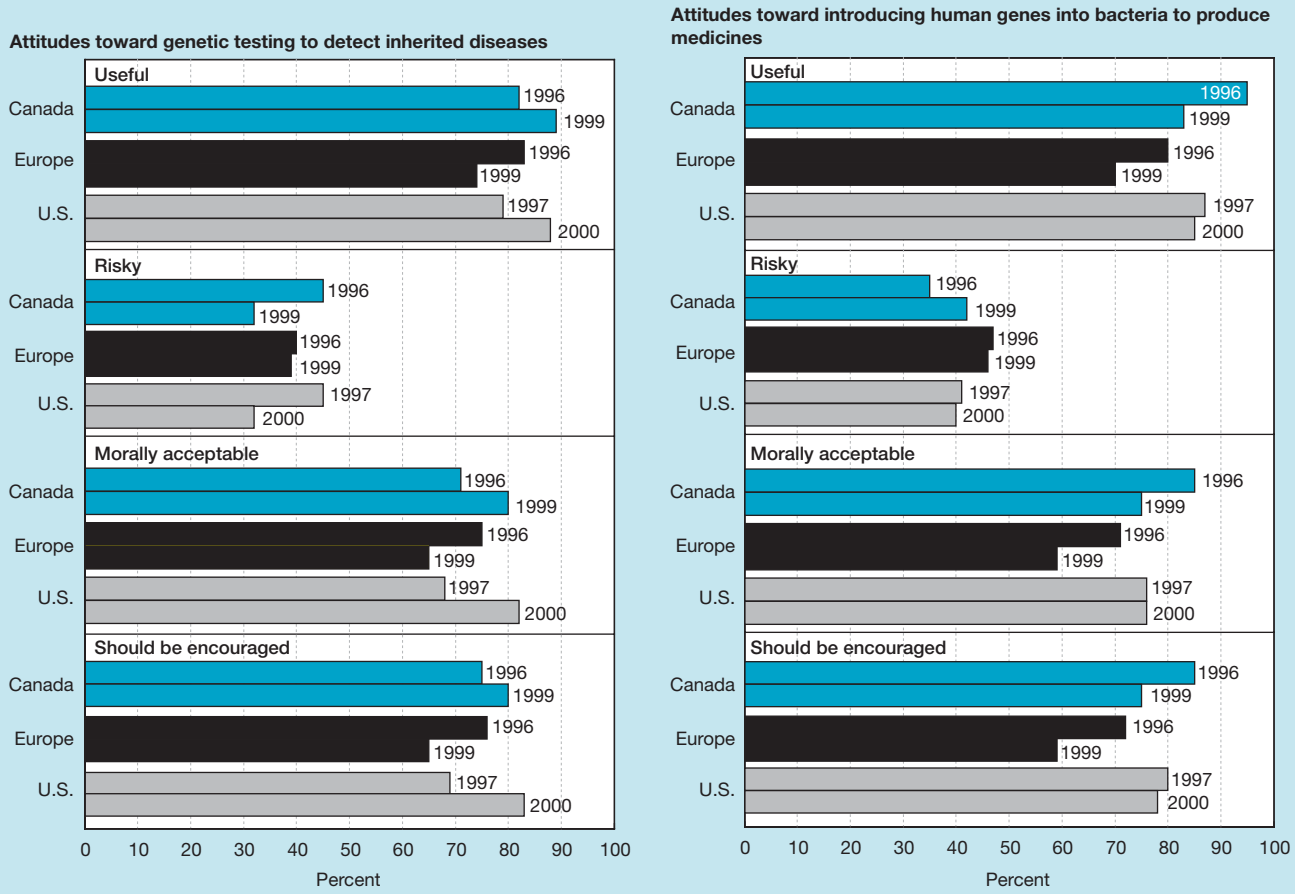
In response to a Gallup poll, 90 percent of those surveyed opposed human cloning and 64 percent opposed animal cloning (Carroll 2001). Support for animal cloning varied by education, income, sex, age, and religion. For example:

- A majority (56 percent) of those having postgraduate education and 52 percent of those having annual in-

*In response to the 2001 NSF survey, 89 percent said that they supported genetic testing to detect inherited diseases; 9 percent were opposed. (See appendix table 7-24.)

†In response to the 2001 NSF survey, 47 percent said that they supported cloning animals; 48 percent were opposed. (See appendix table 7-24.)

Figure 7-10.
Attitudes toward genetic testing and medicine production in Canada, Europe, and the United States



SOURCES: Gaskell, G., and Bauer, M.W. (editors) *Biotechnology 1996–2000,* National Museum of Science and Industry (U.K.) and Michigan State University Press. The 1999 and 2000 surveys were conducted by George Gaskell, Martin Bauer, and Nick Alum for the European Commission; Susanna Priest, Texas A&M University; and Edna Einsiedel, University of Calgary. The 1997 U.S. survey was conducted by Jon D. Miller, Chicago Academy of Sciences.

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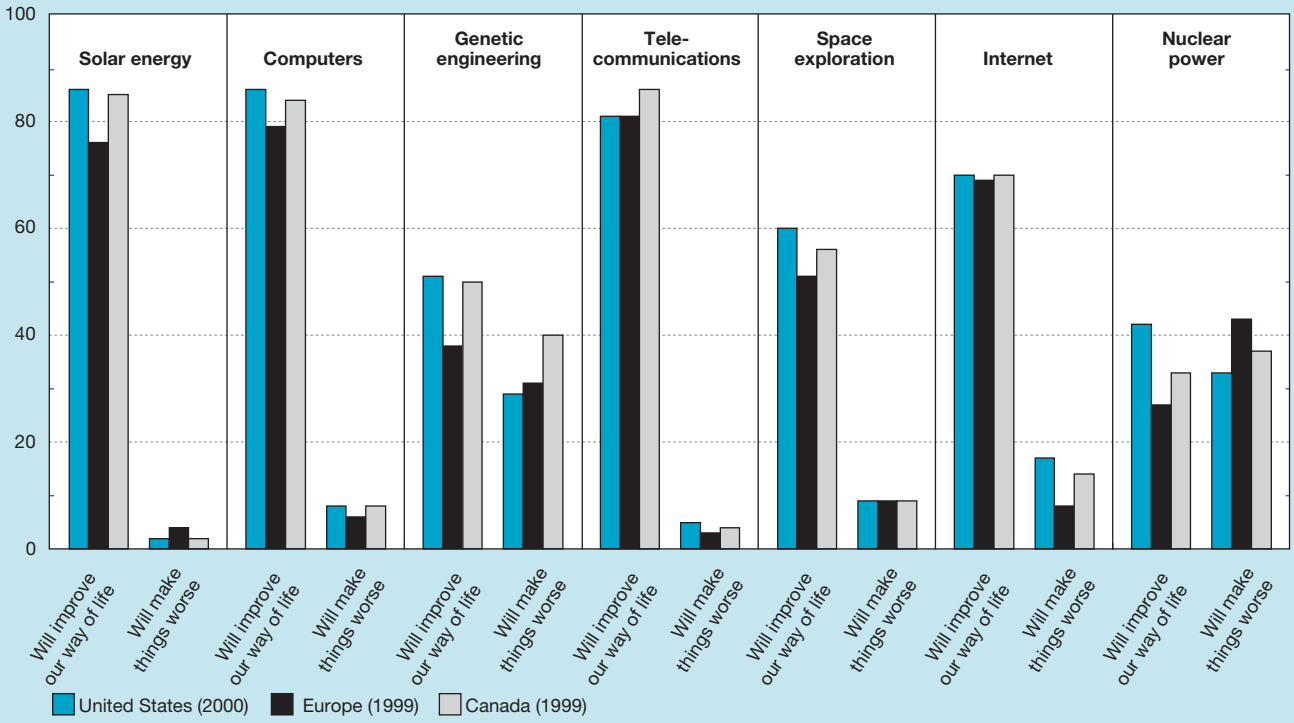
comes above $75,000 said that cloning animals should be allowed. Only 19 percent of those having a high school education or less and 14 percent of those earning less than $20,000 annually shared the same view.

- Seventy-four percent of women but only 53 percent of men opposed animal cloning.
- Seventy-eight percent of those over age 65 opposed animal cloning.
- Only 22 percent of those who said that religion was very important in their lives favored animal cloning compared to 40 percent of those who said that religion was "fairly" important. A majority of those who said that religion was not very important in their lives favored animal cloning.

In response to another poll conducted in early 2001, 90 percent of those surveyed said that it was a bad idea to clone human beings (the corresponding statistic for 1997 was 93 percent) (Time/CNN 2001). Survey respondents cited the following reasons for their opposition to cloning humans: cloning violates their religious beliefs (34 percent), cloning interferes with human distinctiveness and individuality (22 percent), cloning could be used for questionable purposes like breeding a superior race or cloning armies, and cloning is dangerous (14 percent).

The public is somewhat more accepting of human cloning to help infertile couples. In response to one poll, 71 percent said that cloning a human was unethical, but 40 percent thought it would be okay to use cloning to help infertile couples (*Popular Science* 2000). In response to another poll, 20 percent said that cloning would be okay to help infertile couples to have children without having to adopt (76 percent were opposed) (Time/CNN 2001).

Figure 7-11.
Public attitudes toward selected technologies in the United States, Europe, and Canada



SOURCES: Gaskell, G., and Bauer, M.W. (editors) *Biotechnology 1996–2000,* National Museum of Science and Industry (U.K.) and Michigan State University Press. The 1999 and 2000 surveys were conducted by George Gaskell, Martin Bauer, and Nick Alum for the European Commission; Susanna Priest, Texas A&M University; and Edna Einsiedel, University of Calgary.

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Public Perceptions of Selected Technologies, Including Biotechnology

In response to the 1999/2000 surveys, 51 percent of Americans thought that genetic engineering would "improve our way of life in the next 20 years." The corresponding statistics for Europe and Canada were 38 and 50 percent, respectively. However, a sizable minority of Americans (29 percent) said the opposite, that genetic engineering would "make things worse" over the next 20 years compared with 31 percent of Europeans and 40 percent of Canadians. (See figure 7-11.)

How do these statistics compare with those for attitudes toward other technologies? In all three surveys, biotechnology ranked sixth among the technologies respondents were asked about. Only nuclear energy had a lower score, with less than half (42 percent of Americans, 33 percent of Canadians, and 27 percent of Europeans) saying that nuclear energy would improve our way of life in during the next two decades.

In other words, with respect to technologies that will "improve our way of life in the next 20 years," computers and information technology, solar energy, telecommunications, the Internet, and even space exploration received substantially higher numbers of positive responses than biotechnology did. More than 80 percent of Americans and Canadians said that solar energy, computers, and telecommunications would improve our way of life in the next 20 years. The corresponding European percentages were somewhat lower, but still greater than 70 percent. In addition, approximately 70 percent of Americans, Canadians, and Europeans each thought that the Internet would improve their lives during the next 20 years. The corresponding percentages for space exploration ranged from 51 percent (Europeans) to 60 percent (Americans).

Americans, Canadians, and Europeans Take a Pop Quiz on Biotechnology

Americans and Canadians may know more about the science of biotechnology than their European counterparts. On a 10-question quiz, Americans and Canadians averaged 6.2 and 6.1 correct responses, respectively, compared with the European average of 5.4.

One question on this quiz is mentioned just about every time this subject is discussed. Respondents were asked whether the following statement is true or false: "Ordinary tomatoes do not contain genes, while genetically modified tomatoes do."

Less than 50 percent of respondents in all three groups answered this question correctly. That is, 44 percent of

Americans and Canadians and 40 percent of Europeans gave the right answer, which is "false."*

In response to another question, 47 percent of Americans knew that more than half of human genetic makeup is identical to that of chimpanzees (actually it is closer to 98 percent).† Canadians and Europeans did somewhat better than Americans in answering this question correctly, with slight majorities, 52 and 51 percent, respectively, providing the correct answer.

The most difficult question on the quiz was: "Animal genes cannot be transferred into plants."

More Canadians (43 percent) answered correctly ("false") than Americans (36 percent) or Europeans (30 percent).

In the United States (and Canada) opposition to biotechnology does not seem to be related to science literacy or level of formal education. The opposite is true in Europe. That is, in Europe, better educated groups were markedly more positive about encouraging the use of biotechnology than less-educated groups (Priest 2000).

However, those in the United States with extensive university-level science training (those who remember having taken six or more courses in science) were more positive about all six biotechnology applications included in the survey. This difference in support between those with a lot of science education and those without can be seen most clearly in data for the two most controversial applications in the United States: cloning and organ transplants (Priest 2000).

Labeling Issue and Trust in Groups With a Stake in Biotechnology

In spring 2000, various environmental organizations such as the Sierra Club, Friends of the Earth, the Natural Resources Defense Council, Public Citizen, and the Humane Society put together a petition demanding that GM foods be taken off the shelf until they are tested for safety and labeled. Along with health and environmental concerns, labeling is another biotechnology issue that has received an increasing amount of attention in recent years. Data collected with the U.S. biotechnology survey revealed a substantial amount of concern about a lack of government regulation. In other words, the public is concerned about whether the regulatory system functions adequately in this new area (Priest 2000).

Although Americans have been eating food containing GM ingredients for many years, they have been unaware of that fact. Most Americans do not know that the government does not require labels on food to identify GM ingredients.‡ However, most think this type of labeling should be required. Around 85 percent of those surveyed in 1999 and 2000 agreed that the Food and Drug Administration (FDA) should require labeling on all fruits, vegetables, or foods that have been genetically altered (Shanahan, Scheufele, and Lee 2001). About the same percentage agreed that:

> Simply labeling products as containing biotech ingredients does not provide enough information for consumers. It would be better for food manufacturers, the government, health professionals, and others to provide more details through toll-free phone numbers, brochures, and websites.

In the United States, scientists are considered more competent and trustworthy than any other group involved in biotechnology. Scientists received more votes of confidence than the Department of Agriculture, farm groups, the FDA, or the U.S. Environmental Protection Agency. Environmental groups ranked next to last and major biotechnology companies ranked lowest in terms of competence and trustworthiness (Jenkins-Smith et al. 2001).

*In a more recent survey conducted in the United States, 58 percent of the participants provided the correct answer (Jenkins-Smith et al. 2001).

†In a more recent survey conducted in the United States, 55 percent of the participants provided the correct answer (Jenkins-Smith et al. 2001).

‡Approximately one-third (34 percent) of those surveyed answered "false" to the statement, "U.S. regulations require labels to identify any food that contains genetically modified ingredients" (Jenkins-Smith et al. 2001).

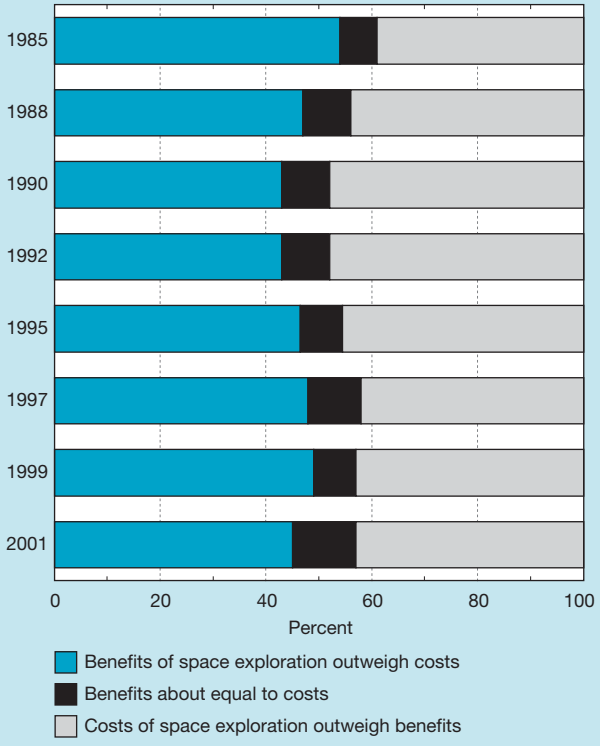
gram. The effects of the Challenger accident (and other mishaps, such as the loss of the billion-dollar Mars *Observer*) are still being felt, and even NASA's recent successes, such as Senator John Glenn's return to space on the space shuttle Discovery in late 1998, have not provided a lasting boost to public opinion. (See figure 7-12 and appendix table 7-25.)

Another survey series (Carlson 2001) has been tracking Americans' views of NASA. In late 1999, 53 percent of those surveyed described NASA's job performance as excellent or good; 43 percent gave the agency a fair or poor rating. In contrast, 76 percent rated NASA's performance as excellent or good following John Glenn's return to space in 1998. The lowest performance rating in this survey series was recorded in September 1993. At that time, only 43 percent thought that NASA's performance was excellent or good.

Like other issues, space exploration receives differing levels of support from men and women. Men are much more likely than women to champion the benefits of space exploration. In every year but two (1990 and 1992), a majority of men responding to the survey agreed that the benefits outweighed the costs, while 40 percent of women held this view. In contrast, during the late 1980s and early 1990s, 50 percent or more of women responding to the survey thought that the costs exceeded the benefits. This is no longer true; in 2001, 45 percent of women thought that the costs outweighed the benefits.

People who have more formal education are more likely than others to say that the benefits of space exploration exceed the costs. In 2001, only 33 percent of respondents lacking a high school education agreed that the benefits outweighed the costs compared with 44 percent of those who had graduated from high school and 55 percent of those who had a bachelor's or higher degree.

Figure 7-12.
Public assessment of space exploration: 1985–2001



See appendix table 7-25. *Science & Engineering Indicators – 2002*

Those identified as attentive to S&T or space exploration are more likely than the public at large to believe that the benefits exceed the costs. In 2001, at least 60 percent of each attentive group put the benefits ahead of the costs compared with less than 50 percent of the public at large.

Public Attitudes Toward Use of Animals in Scientific Research

Few issues in science are as divisive as the use of animals in scientific research. (See appendix tables 7-26 and 7-27.)[29]

Public attitudes toward research using animals are shaped by:

- **The purpose of the research.** Using animals in research to fight diseases such as cancer and AIDS draws less opposition than using animals to test cosmetics.
- **The type of animal.** The public tolerates the use of mice in scientific experiments to a greater degree than the use of dogs and chimpanzees.[30]
- **The existence of alternatives, such as computer simulations.** When researchers can meet their goals without using animals, the public opposes the use of animals (Kimmel 1997).

Data from the NSF surveys and those conducted by other organizations show the following:

- In 2001, 52 percent opposed research using dogs and chimpanzees.
- Compared with the citizens of other industrialized nations, Americans are more supportive of animal research (Kimmel 1997).

In addition, attitudes toward the use of animals in research continue to depend on the sex and age of the respondent. Women are far more likely than men to say they are opposed to the use of dogs and chimpanzees in scientific research. In 2001, 62 percent of women surveyed voiced opposition, but only 40 percent of men held the same view. (See appendix table 7-27.) This gender gap in opinion cannot be attributed to differences between the sexes in science and mathematics education or differences in science literacy (Kimmel 1997). In 2001, the majority of people 54 years of age and younger opposed the use of dogs and chimpanzees in scientific research, whereas a majority of those 65 and older were supportive. (See appendix table 7-27.)

Public Attitudes Toward Global Warming

Americans seem to be listening to what scientists and others have been saying about global climate change.[31] Data from the 2001 NSF survey show that 88 percent of the public had heard of global warming, and of those, 77 percent believed that "increased carbon dioxide and other gases released into the atmosphere will, if unchecked, lead to global warming and an increase in average temperatures." (See appendix table 7-28.) In addition, in assessing the severity of the problem, an overwhelming majority of those surveyed responded that the possibility of global warming should be treated as either a *very serious* (53 percent) or *somewhat serious* (33 percent) problem. (See appendix table 7-29.)

Gallup polls show an increasing number of Americans "worrying" about global warming between 1997 and 2000. In 2000, 40 percent of those polled reported that they worried *a great deal* about the "greenhouse effect," or global warming, up from 24 percent in 1997 and 34 percent in 1999. However, the percentage dropped to 33 percent in 2001. The most recent Gallup data show a decrease in the amount of public concern for all 13 environmental problems included in the survey between 2000 and 2001. (See sidebar "Gallup Polls on Environmental Issues" and text table 7-4.)

[29]In another survey, 71 percent of respondents answered "yes" to the question: "Do you believe the use of animals in medical research is necessary for progress in medicine?" (Research!America 2001).

[30]Fewer people oppose the use of mice in scientific research; 30 percent of those surveyed opposed research on mice compared with 52 percent who opposed research using dogs and chimpanzees. (See appendix tables 7-26 and 7-27.)

[31]The United Nations-sponsored Intergovernmental Panel on Climate Change recently issued a report warning of the catastrophic effects of global warming over the next century. The report represents a consensus of 700 scientists from more than 100 countries (Houghton et al. 2001).

Gallup Polls on Environmental Issues

The Gallup Organization has been tracking public attitudes toward environmental issues for more than a decade. The major findings include the following:

- Americans do not think environmental pollution is one of the most important problems facing the country today. According to a recent Gallup survey, the environment ranked 16th, well below education, the economy, crime, and health care, which top the list of problems identified as the most serious. However, the environment was considered to be the most important problem that will face the United States 25 years from now, more important than Medicare and Social Security and the lack of energy sources, which rank second and third on the list.*
- According to a poll taken in March 2001, 61 percent of respondents believed that global warming is occurring, up from 48 percent who responded the same way in November 1997 (Newport and Saad 2001). The same percentage also believes that human activities are more responsible for increases in the Earth's temperature over the last century than natural causes (one-third of those surveyed said the latter). In addition, 34 percent of those surveyed thought that news reports about the seriousness of global warming are accurate, and another 32 percent thought they were underestimating the problem, leaving only 30 percent who think the press is exaggerating the problem. Although Americans seem to be aware of the issue and believe press reports, they do not appear to be all that concerned. On a list of 13 types of environmental worries, the greenhouse effect, or global warming, ranked 12th. (See text table 7-4.)
- Given a choice of two statements, "protection of the environment should be given priority, even at the risk of curbing economic growth" or "economic growth should be given priority, even if the environment suffers to some extent," most respondents agreed with the first. However, the percentage agreeing with the first statement declined from 70 percent in January 2000 to 57 percent in March 2001, the lowest percentage recorded since this question was first asked (in September 1984).
- Most respondents (56 percent) opposed opening up the Alaskan Arctic Wildlife Refuge for oil exploration and 51 percent opposed expanding the use of nuclear energy. In addition, most (62 percent) opposed setting legal limits on the amount of energy an average consumer can use. But nearly 80 percent favored strengthening enforcement of Federal environmental regulations. Also, in March 2001, 52 percent (versus 36 percent) of those surveyed picked the statement "protection of the environment should be given priority, even at the risk of limiting the amount of energy supplies—such as oil, gas, and coal, which the United States produces" over the alternative statement "development of U.S. energy supplies, such as oil, gas and coal, should be given priority, even if the environment suffers to some extent."

*Another survey found scientists to be more concerned than those in other professions about the global environment. That is, they were more likely to agree that "improving the global environment" should be a top priority (they were also more concerned about population growth) (Pew Research Center for People and the Press 1997).

Public Attitudes Toward Science and Mathematics Education

Public discontent with the quality of science and mathematics education in the United States persists. As noted earlier in the chapter, surveys taken shortly before the 2000 presidential election revealed education to be at or near the top of lists of the most important problems facing the country.[32]

In response to the 2001 NSF survey, 68 percent of those queried agreed that "the quality of science and mathematics education in American schools is inadequate."[33] The percentage of survey respondents agreeing with this statement has ranged from 63 percent in 1985 and 1999 to 75 percent in 1992. Unlike other survey items, this question revealed no gender gap with respect to attitudes toward the quality of science and math education. (See appendix table 7-30.)

However, a strong positive correlation does exist between level of education and finding fault with the quality of science and math education. In 2001, 52 percent of respondents who had less than a high school education were dissatisfied with the quality of science and math education. In comparison, 68 percent of high-school-only graduates agreed with the statement, as did 76 percent of college graduates.

In another survey, more than 90 percent of those queried agreed that students in their states needed a stronger education in science and math "to be prepared for the new inventions, discoveries, and technologies that the increased investment in research and development will likely bring," and 85 percent agreed that "improving precollege science education should be one of [their] governor's top education priorities." Finally, 82 percent said they would be more likely

[32]However, according to another survey, 66 percent of the public thinks the public education system will improve in the next 50 years; 30 percent said it will get worse (Pew Research Center for People and the Press 1999a).

[33]According to another survey, conducted in August 2000, 61 percent of the public is either somewhat or completely dissatisfied with the quality of education in the United States, an increase over the percentage recorded the previous year (Gallup News Service 2001b).

Text table 7-4.
Environmental worries

Issue	Worry "a great deal" (percent)			
	1997	1999	2000	2001
Pollution of drinking water	NA	68	72	64
Pollution of rivers, lakes, and reservoirs	NA	61	66	58
Contamination of soil and water by toxic waste	NA	63	64	58
Contamination of soil and water by radioactivity from nuclear facilities	NA	48	52	49
Air pollution	42	52	59	48
Loss of natural habitat for wildlife	NA	51	51	48
Damage to Earth's ozone layer	33	44	49	47
Loss of tropical rain forests	NA	49	51	44
Ocean and beach pollution	NA	50	54	43
Extinction of plant and animal species	NA	NA	45	43
Urban sprawl and loss of open space	NA	NA	42	35
"Greenhouse effect" or global warming	24	34	40	33
Acid rain	NA	29	34	28

NA = not available

SOURCE: Gallup Organization, "Only One in Four Americans Are Anxious About the Environment," Poll Release (Princeton, NJ, 2001).

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to vote for a presidential candidate in the November 2000 election if the candidate supported Federal efforts to strengthen U.S. science and math education (Bayer/NSF 2000).

Two NSF/Bayer surveys conducted in 2000 and 2001 included questions about public attitudes toward the results of the Third International Math and Science Study (TIMSS). One of the key findings of TIMSS, first conducted in 1995 and repeated in 1999 (see chapter 1, "Elementary and Secondary Education"), was that high school seniors in the United States performed poorly in tests of their knowledge of science and math. In fact, they ranked last or nearly last among the students who participated in TIMSS.

According to the 2000 NSF/Bayer survey, most people were unaware of the TIMSS results, although they received a considerable amount of coverage in the press. Only 7 percent of those queried knew that the scores of U.S. seniors were considerably lower than those of students in most other participating countries; nearly 50 percent thought that U.S. students scored average or higher. However, after being informed of the TIMSS results, almost everyone expressed concern, and 52 percent said that they were very concerned.

In 2001, two-thirds of NSB/Bayer survey respondents considered the TIMSS-R results a warning sign that "U.S. students may be inadequately prepared for the workplace when they enter it in several years."

Public Image of the Science Community

It is generally conceded that scientists and engineers have somewhat of an image problem (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development 2000). Although their intelligence and work are highly respected (see "Public Confidence in Leadership of the Science Community"), that admiration does not seem to extend to other aspects of their lives. The charming and charismatic scientist is not an image that populates popular culture.[34] For example, the entertainment industry often portrays certain professions such as medicine, law, and journalism as exciting and glamorous, whereas scientists and engineers are almost always portrayed as unattractive, reclusive, socially inept white men or foreigners working in dull, unglamorous careers. (See sidebar "Few Scientists in Prime Time.")

Why does public image matter? What difference does it make if the public image of scientists and engineers is less than positive? Public image is important for at least two reasons:

- Scientists represent the first line of communication about science to the general public. That is, they are responsible for conveying information, often through the news media, about scientific issues. They can also help the public understand the importance of science and appreciate its benefits. Image has a lot to do with how effective that communication is in capturing the attention of the public. The more appealing the image, the more likely that people will listen to what is being said.

[34]See Goldman (1989). Theater also helps reinforce the stereotype, In the recent, Pulitzer prize and Tony-winning play *Proof*, mathematicians are portrayed as "a bunch of brilliant but crazy nerds who do things that are impossible to understand" (Davis 2001). Others, however, like author, screenwriter, and physician Michael Crichton defend Hollywood's depiction of science and technology. Movies such as *Jurassic Park* provide a needed balance to the "round-the-clock boosterism" science and technology usually receive in our society. According to Crichton (American Association for the Advancement of Science annual meeting in Anaheim California 1999), scientists are not the only professionals negatively portrayed on the big screen. Accountants, police officers, and politicians also frequently receive less than positive treatment.